Space Weather Technical Forecast

Issued on Tuesday 21 January 2025 at 13:13 Local

This technical forecast provides a four-day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Isolated M-class flares likely, with a slight chance of X-class flares. Chance of Active electron fluence.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Moderate, with a peak M3.3 flare at 21/1039 UTC from the region of AR3967. There are ten sunspot regions on the Earth-facing disc with the departure of AR3968. AR3961 remains the largest sunspot group, the magnetic configuration of the sunspot is complex, with a Beta-Gamma-Delta Mount Wilson classification, with weak delta regions around the intermediate portion. AR3964 and AR3959 are both moderately sized spots, neither of which have shown any significant change in recent hours. Confidence in the magnetic configuration of AR3968 is low however, given increased foreshortening as it approaches the western horizon. All remaining spots are small and have shown little change, though a lack of recent imagery gives lower confidence.

An apparent CME associated with the recent M-flare and likely filament eruption is under review pending imagery.

Solar Wind / Geomagnetic Activity: Ongoing fast winds from CH09/- were observed. Solar wind speed, as measured by ACE and DSCOVR saw a slight decline from strong to elevated levels, reaching 650-550km/s. Density was below average. The Interplanetary Magnetic field, Bt, was Weak and declining, with the north-south component, Bz, varying between +6/-7nT, with no single orientation favoured. Phi angle was mainly negative (towards the Sun). Geomagnetic activity was Quiet to Active (Kp2-4).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10MeV) at GOES18 was at Background. High energy electron flux (greater than 2MeV) at GOES16 was mainly Moderate, peaking 1180pfu at 20/1330UTC. The associated 24-hour fluence persisted below the Active threshold, reaching 3.06e7 integrated pfu at 21/0000UTC.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is forecast, with isolated M-class flares likely and a slight chance of X-class flares.

Solar Wind / Geomagnetic Activity: There are no CME arrivals currently forecast for Earth, however a glancing impact from a CME on 18 Jan cannot be completely ruled out early day 1 (21

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Jan). A CME awaiting analysis also brings a risk towards the end of the period. Largely Quiet to Unsettled geomagnetic activity is expected, with a reducing chance of Active intervals through the period as the current elevated solar winds associated with CH09/- steadily ease. There is a slight chance of G1/Minor geomagnetic storm intervals however, these most likely early day 1 (21 Jan), and into day 4 (24 Jan) if any CME impacts occur.

Energetic Particles / Solar Radiation: GOES18 high energy proton flux is expected to be at Background, but with a slight chance of enhancements exceeding the S1 Minor Radiation Storm threshold should any notable flares occur. GOES16 high energy electron flux is forecast to be Moderate to High, although the longevity of the periods of High is low confidence. The associated 24 hr fluence is expected to see an increasing chance of rising above the Active threshold (1e8 integrated pfu) through days 1 and 2 (21-22nd Jan), with a likelihood thereafter.

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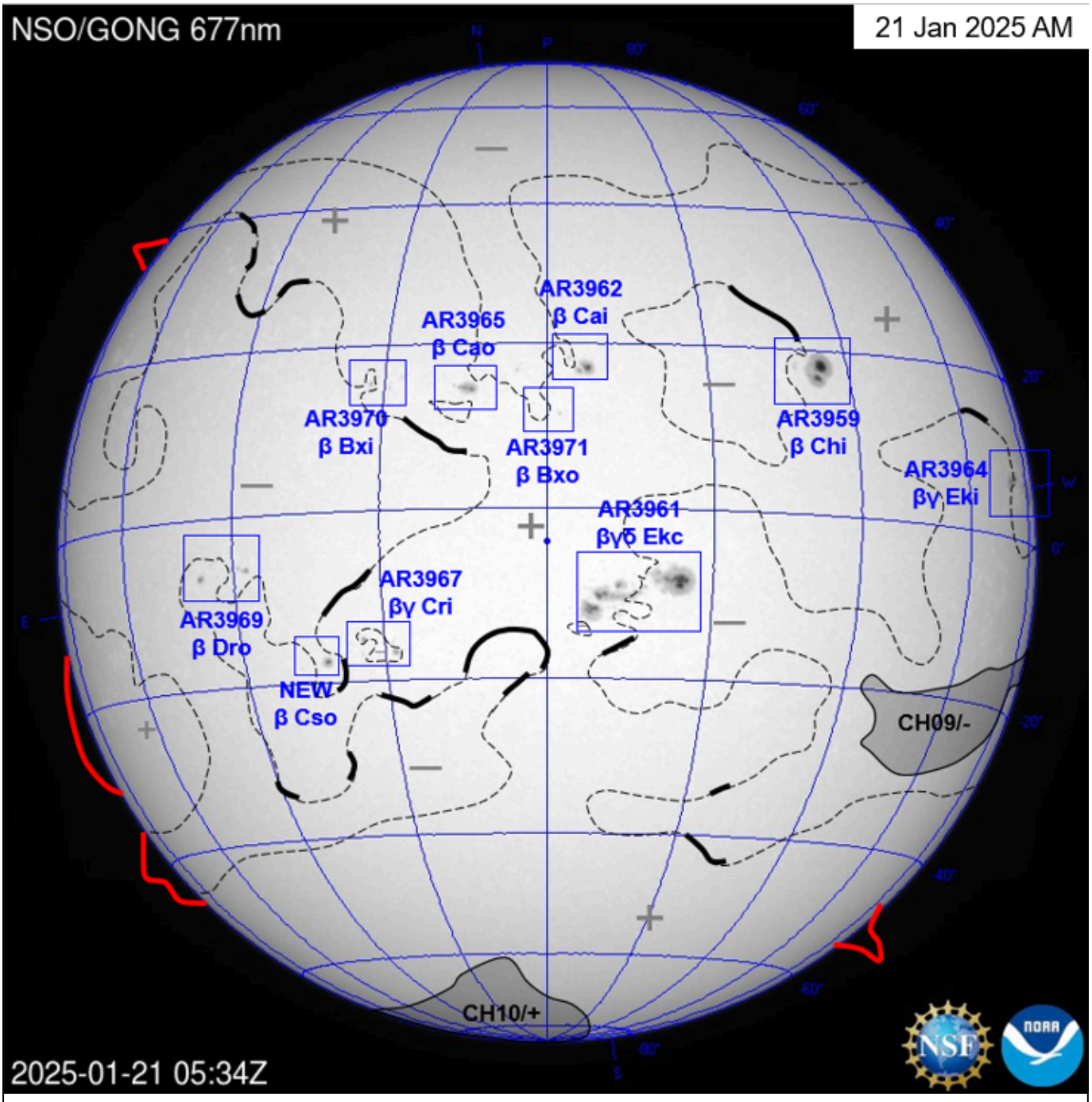
Figure 1: Solar Synoptic Map valid 21/0530 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms

There are no significant CMEs currently forecast to impact Earth. However a weak eruption from AR3964 early on 18 Jan is expected to pass close to Earth, likely just ahead and north of its orbit. This has a small chance to give a very slight glancing impact on day 1 (21 Jan), as it passes nearby. A CME associated with the recent M-flare and associated filament disruption in the southeast disk still awaits imagery for a full analysis, however preliminary empirical analysis suggests the potential risk of a glancing impact into day 4 (24 Jan).

Solar winds are currently dominated by fast wind from the large and longitudinally wide CH09/-. Elevated solar winds are expected to continue on day 1 (21 Jan), erratically easing through the forecast period, to likely become near background by day 4 (24 Jan) not withstanding any CME impacts. This gradual decline is supported by MOSOWC ENLIL model output which is viewed as providing reasonable guidance.

Largely Quiet to Unsettled geomagnetic activity is expected, with a reducing chance of Active intervals through the period. There is a slight chance of G1/Minor geomagnetic storm intervals however, these most likely early day 1 (21 Jan), and into day 4 (24 Jan) if any CME impacts occur.

Geomagnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	5	5	20
Strong	G3	No	1	1	1	5
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

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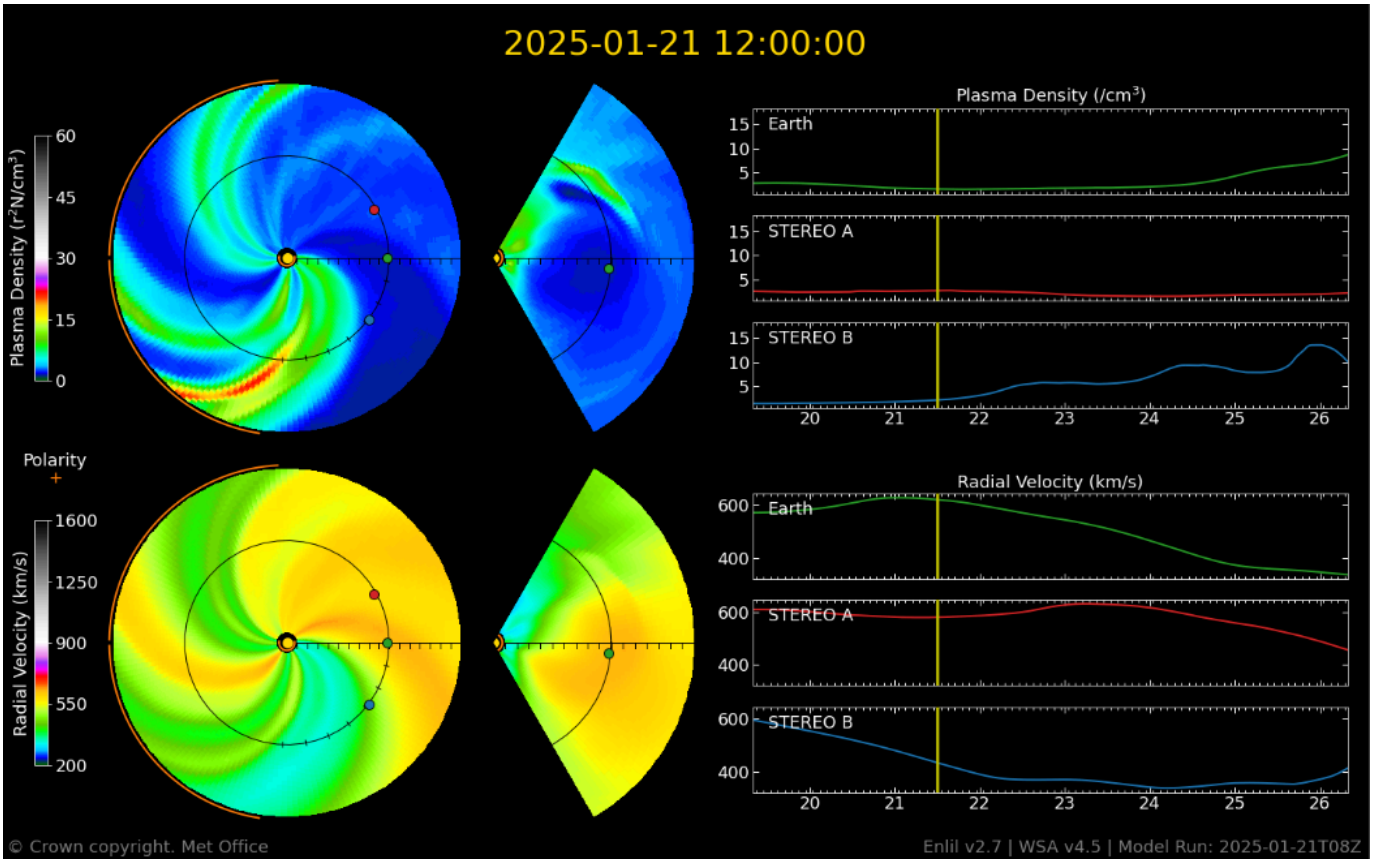
Figure 2: Latest MOSWOC ENLIL output.



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Radio Blackouts - X-Ray Flares

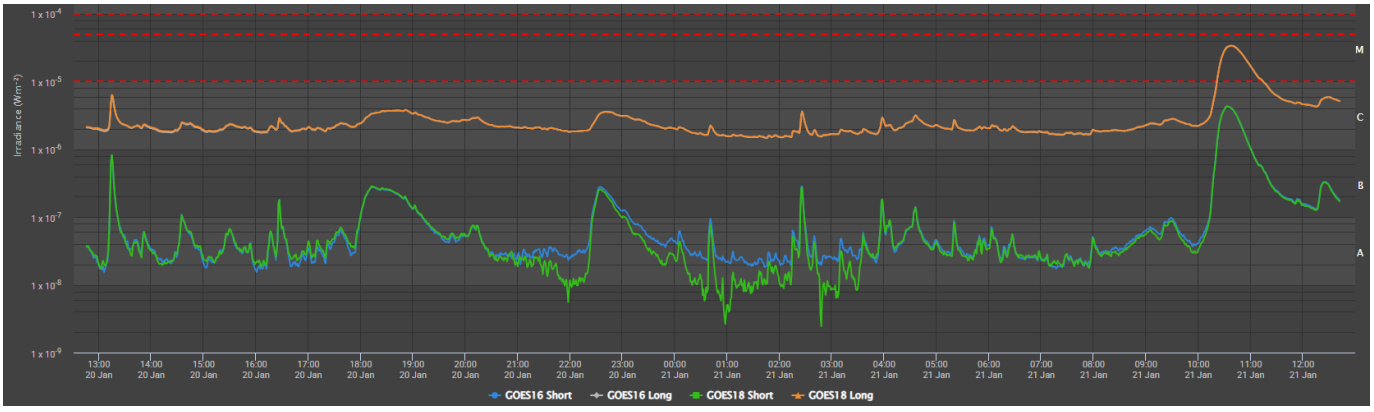
There are ten sunspot regions on the Earth-facing disc with the recent growth trend evident in observed flux showing some signs of levelling, and for now flare activity has continued to be largely muted until the most recent M-flare. AR3961 remains the largest sunspot group and the magnetic configuration of this sunspot is complex, with a Beta-Gamma-Delta classification as weak delta regions have developed around the intermediate portion. AR3964 in the northeast also continue to contribute to the flare potential, although given increased foreshortening as it approaches the western horizon sees confidence in the evolution of this region becoming low. Remaining spots are generally smaller and have shown little change.

Of the more significant sunspot regions currently on the disc, AR3964 is the most notable to rotate over the western limb during the period, into day 2 (22 Jan). Although a number of returning regions are expected in the forecast period, far sided helio-seismic soundings do not currently infer the presence of any strong active regions close to the eastern limb. On balance perhaps a slight reduction of forecast flare probabilities during the period, depending on any development of the sunspots currently on the facing-disc but for now forecast is maintained at current levels.

Overall Moderate activity is forecast, with isolated M-class flares likely and a slight chance of X-class flares.

X-Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 (M Class)	Yes	70	70	70	70
Very Active	R3-R5 (X Class)	No	15	15	15	15

Figure 3: Latest 24hr GOES18/18 X-Ray trace.



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Solar Radiation Storms (High Energy Protons)

GOES18 high energy proton flux has persisted at Background levels. There is a slight chance of enhancements exceeding the S1 Minor Radiation Storm threshold should any notable flares occur. This includes any activity from AR3964 in the northwest disc, even as it rotates around the limb in the coming days, or from AR3961 nearer the central meridian in the southern hemisphere.

Radiation Storms Probability (Exceedance)	Level ($cm^{-2}sr^{-1}s^{-1}$)	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and/or 50 MeV ≥ 10pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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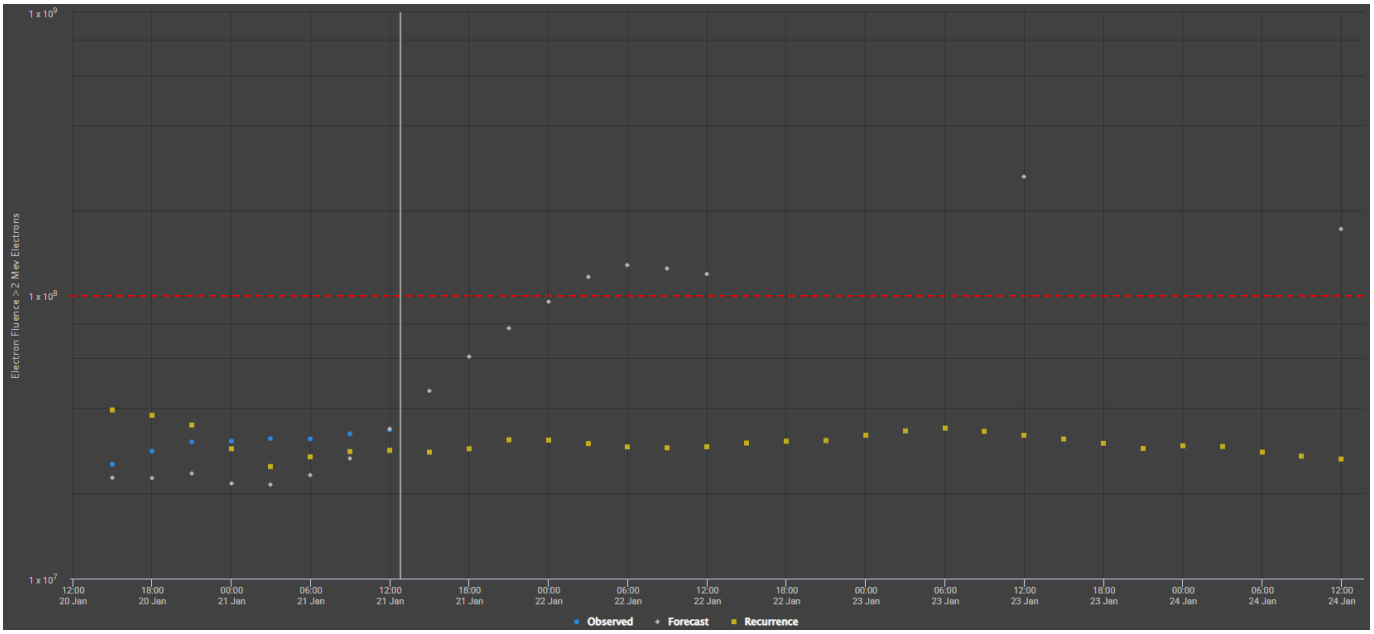
High Energy Electrons (≥ 2MeV)

High energy electron flux observed at GOES16 has been at mostly Moderate and briefly High levels in the past 24 hours, as a result of the recent extended period of slightly elevated to elevated solar winds. As these winds ease, any charging of the Radiation Belt is likely to expand outward, with the diurnal peak period at GEO increasingly likely to reach High levels. However, the longevity of these periods of High flux is currently low confidence due to the lack of any notable geomagnetic activity leading to some uncertainty with the extent of any charging. Furthermore, there is a slight chance of a glancing CME arrival early day 1 (21 Jan), which could help to drop out the observed flux at GEO.

Subsequently, the associated 24 hr fluence has an increasing chance of becoming Active (1e8 integrated pfu) days 1 and 2 (21-22 Jan), with a likelihood thereafter. MOSWOC REFM has a similar rising trend, and is currently deemed to be giving reasonable guidance given the forecast uncertainties.

GEO Electron Environment	Level ($cm^{-2}sr^{-1}$ day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ 1×10^{8}	No	30	50	60	60
Very Active	≥ 2 MeV ≥ 1×10^{9}	No	1	1	1	1

Figure 4: Latest MOSWOC REFM output.



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